

it is spaced from the free ends 116 of the leads 115. The die 120 includes an upper (first) surface 122 and a lower (second) surface 124, and also includes a plurality of die bond pads 126 located on the upper surface 124. The die bond pads 126 are electrically connected to the integrated circuit (not shown) which is fabricated on the die 120, and are also electrically connected to the upper surfaces 112 of selected leads 115 via wires 130 using known wire bond techniques. A plastic casing 160 is formed over lead frame 110, die 120 and wires 130 for protection.

In accordance with a first aspect of the present invention, the lower surfaces 114 and 124 are exposed through the plastic casing 160, thereby facilitating rapid heat dissipation from the die 120, and thereby enhancing thermal performance of the electronic device 100. In particular, when the electronic device 100 is mounted on a circuit board in a "cavity up" arrangement (i.e., such that the lower surfaces 114 and 124 face a surface of the circuit board), the die 120 can be mounted directly onto a heat sink formed on the circuit board. The direct contact between the die 120 and the heat sink provides significantly better heat dissipation over that of the known enclosed-die package shown in FIG. 1 of the present application. The electronic device 100 can also be beneficially used in a "cavity down" arrangement (i.e., such that the lower surfaces 114 and 124 face away from the printed board) by providing suitable ventilation and/or a heat sink structure mounted directly onto the die 120.

In accordance with a second aspect of the present invention, the lower surface 114 of the lead frame 110 is co-planar with a lower surface 124 of the die 120. This arrangement yields a very low-profile package when compared with the known enclosed-die package shown in FIG. 1 of the present application.

FIGS. 2-6 show a method for producing an electronic device using the plastic package formed in accordance with the present invention.

Referring to FIGS. 2A and 2B, the lead frame 110 is formed from a thin metal (e.g., copper) strip which has been etched or stamped to form a pattern similar to that shown in FIG. 2A. The upper (first) surface 112 and the opposing lower (second) surface 114 are indicated in FIG. 2B. Each of the radial leads 115 has a free end 116 and a fixed end 117. The free ends 116 of the plurality of leads 115 surround and define the central opening 118. The fixed ends 117 of the leads 115 are connected to a skirt 119, which is removed after the plastic casing 160 is formed, as described below. It is noted that the lead frame 110 shown in FIG. 2A is simplified for clarity. A lead frame 110 used in an actual package may have a different shape than that shown in FIG. 2A, and typically includes many more leads 115.

Referring to FIG. 3, the lead frame 110 is mounted on an adhesive tape 170 such as polyimide with an adhesive layer. The purpose of the adhesive tape 170 is to support the die 120 and lead frame 110 during the assembly process, and to maintain the die 120 in a proper location relative to the lead frame 110. Specifically, the lower surface 114 of the lead frame 110 contacts a sticky surface 172 of the adhesive tape 170, and the upper surface 112 of the lead frame faces away from the adhesive tape 170. A central portion 174 of the adhesive tape 170 remains exposed through the central opening 118 of the lead frame 110.

Referring to FIG. 4, the die 120 is then mounted on the central portion 174 of tie adhesive tape 170. Specifically, the die 120 is positioned in the central opening 118 such that the lower surface 124 of the die 120 contacts the sticky surface 172 of the adhesive tape 170, and the upper surface 122 of the die 120 faces away from the adhesive tape 170. The sticky surface 174 supports the lead frame 110 and the die 120 such that the lower surfaces 114 and 124 are co-planar.

Referring to FIG. 5, wires 130 are then connected between the die bond pads 126 and the leads 115 using known wire bond techniques.

Referring to FIG. 6, the molded plastic casing 160 is then formed over lead frame 110, die 120 and wires 130 using known plastic molding methods (such as transfer molding) while the lead frame 110 and die 120 remain mounted on the adhesive tape 170. During the molding process, liquified molding material flows onto exposed portions of the adhesive tape 170 which are located between the die 120 and the free ends 116 of the lead frame, and between the leads 115. This molding material solidifies to form intervening portions 162 which serve to maintain the relative positions of the die 120 and leads 115. After encapsulation, skirt 119 is removed by trimming.

Finally, as shown in FIG. 7, the adhesive tape 170 is removed from the die 120 and the lead frame 110, thereby exposing the lower surface 124 of the die 120, the lower surface 114 of the lead frame 110, and lower surfaces 164 of the intervening portions 162, all of which being co-planar.

The device 100 shown in FIG. 7 can be attached to a circuit board using several possible methods. For example, a BGA package format may be obtained by trimming the leads 115 such that they are flush with a side surface 166 of the plastic casing 160, and attaching solder balls or columns to the lower surfaces 114 of the leads 115. Alternatively, the skirt 119 can be removed by cutting the leads 115 near the fixed ends 117, and then bending the leads to provide contact with a circuit board.

While particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from this invention in its broader aspects. For example, the lead frame may have any known configuration, and is not intended to be limited to the construction of lead frame 110 shown in FIGS. 2A and 2B. Further, the steps of mounting the die 120 and lead frame 110 onto the adhesive tape 170 shown in FIGS. 3 and 4 may be reversed. Moreover, glob top material may be used in place of the molded plastic casing 160. Therefore, the appended claims are to encompass within their scope all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. A method for producing an electrical device comprising the steps of:

forming a flat lead frame including a plurality of leads extending radially from a central opening, the lead frame having opposing upper and lower surfaces;

mounting the lead frame and an integrated circuit die onto a strip of adhesive tape such that a lower surface of the die contacts the adhesive tape and the die is located in the central opening, and the lower surface of the lead frame also contacts the adhesive tape;

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forming a plastic casing over an upper surface of the die and the upper surface of the lead frame; and removing the adhesive tape to expose the lower surfaces of the die and the lead frame.

2. The method according to claim 1, wherein the die includes a plurality of die bond pads, and the method further comprises the step of electrically connecting each of the die bond pads to a selected one of the plurality of leads.

3. The method of claim 2, wherein the step of electrically connecting comprises wire bonding.

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4. The method of claim 1, wherein the step of forming the lead frame comprises etching a metal sheet.

5. The method of claim 1, wherein the step of forming the lead frame comprises stamping a metal sheet.

6. The method of claim 1, wherein the step of forming the plastic casing comprises molding plastic onto the upper surfaces of the die and the lead frame.

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